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CLIMATE CHANGE ADAPTATION ON LAND COVER OF SAND DUNES ECOSYSTEM PARANGTRITIS COASTAL AT BANTUL REGION, DAERAH ISTIMEWA YOGYAKARTA, INDONESIA

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ABSTRACT

Interpretation of imagery in 2003, 2010, and 2016 shows the changing patterns of land cover on coastal areas at Parangtritis Bantul. This change was triggered by climate change factors, especially rainfall. The study aims to: 1) mapping the pattern of land cover change on coastal sand dune Parangtritis ecosystem and its relation to climate change occurs; 2) determine the forms coastal sand dune ecosystem adaptation due to the climate change.

The study was conducted by surveying and mapping. Firs creating a map of land cover temporally. Map of the pattern of land cover 2003 and 2010 of land area was obtained by image interpretation. The pattern of land cover in 2016 was obtained from the existing mapping month from May to September 2016. The changes pattern of land cover is shown by the calculation of the area coverage and type of land cover from time to time. Climate change is seen by the trend analysis of rainfall last 19-28 years. The link between land cover and climate change were analyzed descriptively. The forms observed adaptation of the dominant vegetation growing as land cover in the zone of active sand dunes.

The results showed that from 2003 to 2016 a reduction in the extent of land cover types such as moor, natural bush, cultivated plants, ponds, and settlements. Land cover types shoals and sandbanks open beaches are also reduced. Rainfall trend analysis showed that the study area has increased the amount of rainfall. The rainy season in the area the research took place between the months of November to June, while the dry season lasts between the months of June to October. Adaptation form occurs that is increasingly broad and diverse types of vegetation found in sand dune ecosystems. The dominant vegetation that found such as grass run, pandanus thorns, thistle, Ipomea, cassava, gamal, fir shrimp, and dragon fruit.

Keywords: Climate Change Adaptation, Land Cover Pattern, Sand Dunes Ecosystem

1 INTRODUCTION

Sand dune ecosystem in the study area shows the typical landforms and interesting. Ecosystems are sandbanks and thrive on the coast, so it is also known as coastal sand dune ecosystem. Landforms sandbanks sized material composed of 0.5 to 0.125 mm (medium sand - fine sand) and incoherent (not solid). Such materials may be displaced by wind activity. Activities wind, human activity, and the presence of vegetation affects deformation specific topographic sandbanks. Aerial photography in 1972, 1982 and 2006

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reflect the changes in the coastal sand dune ecosystem parangtritis. It is believed to be related to the presence of current climate change.

The research area is located in the southern part of Bantul regency, Yogyakarta. The area is a coastal sand dune ecosystem that stretches from the west - east. Research area bounded on the sand dunes in the Core Zone (ZIGP) covering an area of 141.5 hectares which refers to the study of statutes Number: UGM/GE/3346/M/09/15 by the Geospatial Information Agency (BIG) in collaboration with the Faculty of Geography.

Interpretation of imagery in 2003, 2010, and 2016, and the results of topographic mapping in September 2016 shows the changing patterns of land cover in the area of coastal sand dunes Parangtritis Bantul. This change was triggered by climate change factors, mainly rainfall and wind. This study aims to: 1) mapping the pattern of land cover change on coastal sand dune Parangtritis ecosystem and its relation to climate change occurs; 2) determine the forms coastal sand dune ecosystem adaptation due to the climate change.

2 METHOD

2.1 Tools and Materials

Tools and materials required include: GPS; Compass; DISTO laser meter; Map the administrative area of research; The image of the study area in 2010, 2013 and 2016; Map RBI research areas; Geologic Map; and Data Rainfall from the nearest station.

2.2 The ways of working

Research in the three stages: preparation, phase field, and post-field phase (analysis).

2.3 Preparation phase

The preparation stage includes the study of literature and collection of secondary data, the image of the study area in 2003, 2010, and 2016; topographical map scale of 1: 25,000; Data cantonal (administration); geological map; rainfall data. Furthermore, the digitization and interpretation of such earth imagery and maps available to describe the land cover in 2003, 2010, and 2016 are still tentative (temporary). In the preparation phase also conducted an analysis of rainfall data last 19-28 years in the research area.

2.4 Stages of fieldwork

Basically stages of field work conducted by survey and mapping. Field work begins with a detailed topographic mapping. 2016 land cover map obtained by mapping the existing basis for 4 months (May-September 2016). Field work includes:

2.4.1 Detailed topographic mapping

Topographic maps created with the scale of 1: 2000, contour interval of 1 meter. The results of topographic mapping in the form of a topographic map that describes the shape of the terrain in detail, both on open land and terrain covered with vegetation. Topographic maps are used as a base map.

2.4.2 Inspection and mapping of land cover.

Map land cover temporary (tentative) interpretation of the results of such earth map scale of 1: 25,000 and satellite images in the next field preparation stage in cross-checked in the field. If there are conditions and the type of land cover that have not been recorded on a visual map of the earth and satelite imagery, then do the mapping for improvement. Land cover map can describe the use of land, used as a basic reflection of the dynamics of human activity in changing the shape of sand dunes. From the mapping of land cover and then calculated the extent of each form of land cover so it can be seen the changing patterns of land cover in the study area is temporally.

2.4.3 Observation types of vegetation dominant land cover in the study area

Observation of the vegetation types is done directly, especially on the dominant species. Types of observed natural vegetation ecosystem is divided into sand dunes and vegetation result of human activities. The observation of this time compared to other types of vegetation found on the sand dune ecosystems are generally in the sandbanks in the past.

2.5 Stages of Post-Courses

In the post-field phase, the activities carried out include: analysis of the climate (rainfall and wind, and extensive analysis of changes in land cover types, and analysis of adaptation based on the types of vegetation found as land cover.

The research area includes wet tropical climate, so in particular a change between the rainy season and dry season. Determining the pattern of rainy and dry seasons required each year for each station of rainfall. Analysis of rainfall is needed because rain can cause the material to be wet and high humidity. Determine the pattern of the rainy season (in wet, humid and dry) using a classification according to Mohr, 1933 in Bayong, 2004 as follows:

a. category analogous to a wet month rainy season, when rainfall> 100 mm/month.
b. category in humid analogous to the transition from rainy season to dry and vice versa, when rainfall 60-100 mm / month.
c. category analogous to a dry month dry season, when rainfall <60 mm/month.

Rainy season pattern is visualized in the form of tables and graphs. Furthermore, the range of rainfall can scoring counted and categorized based on Table 1 below.

Table 1. Levels of dignity to the range of precipitation

Rainfall Range (mm/year)	Scor	
	Category	Magnitude
< 500	less	5
501 – 1,000	a little	4
1,001 – 2,000	moderate	3
2,001 – 2,500	many	2
> 2,500	more	1

Trends Analysis (Trend Analysis) Rainfall intended to see fluctuations in the rainfall. If the pattern is the tendency of the amount of precipitation decreases, indicating indication of the drought and vice versa. Before performing trend analysis of rainfall, the normality test of rainfall data. Normal spread data will form a straight line. If the data is not a normal distribution, the data will be biased. To overcome this, the data must be transformed in logarithm. Data normality test area of research conducted by the Shapiro-Wilk test approach, with a significance level of 5%. Provisions Ho (H zero) that the normal distribution of data if P_VALUE> 0.05, whereas the normal distribution of data will be rejected if the value P_VALUE <0.05.

The link between changes in land cover and climate (rainfall) were analyzed by descriptive comparative. The forms of adaptation was observed from the dominant vegetation growing in the research area.

3 RESULT AND DISCUSSION

3.1 Changes in land cover patterns

Land cover is defined as a form of human intervention using land and natural vegetation growing on that land. Interpretation of satellite imagery in 2003, 2010, and 2016 showed changes in land cover (land cover) from year to year. Land cover is defined as a form of human intervention using land and natural vegetation growing on that land. Interpretation of satellite imagery in 2003, 2010, and 2016 showed changes in land cover (land cover) from year to year. Topographic mapping results are shown in Figure 1. The land cover map is presented in Figure 2, 3, and 4. The extent and type of land cover change can be seen in Table 2.

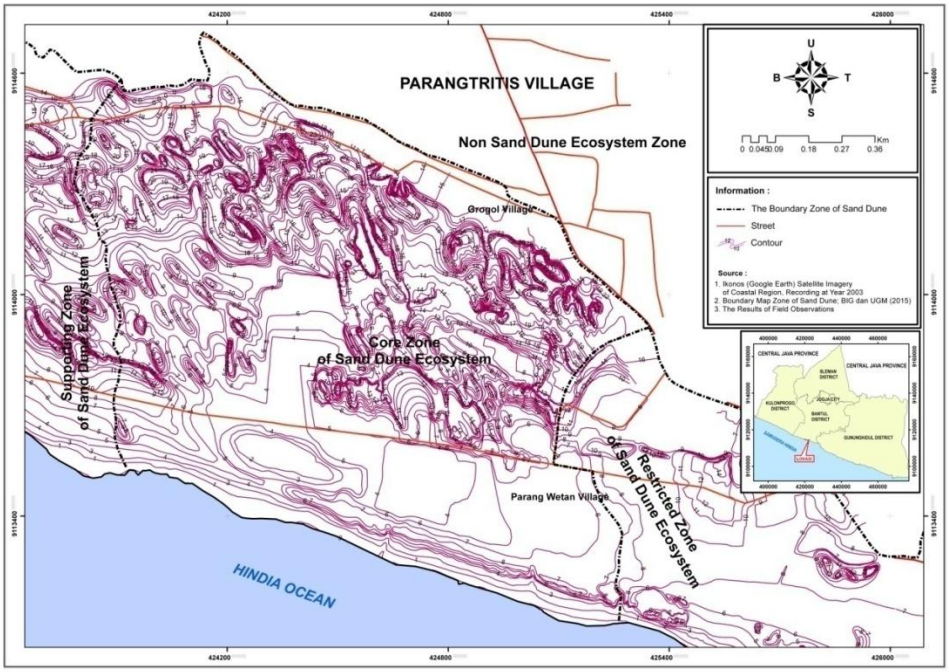

Figure 1. Topographic Map Regional Research, September 2016

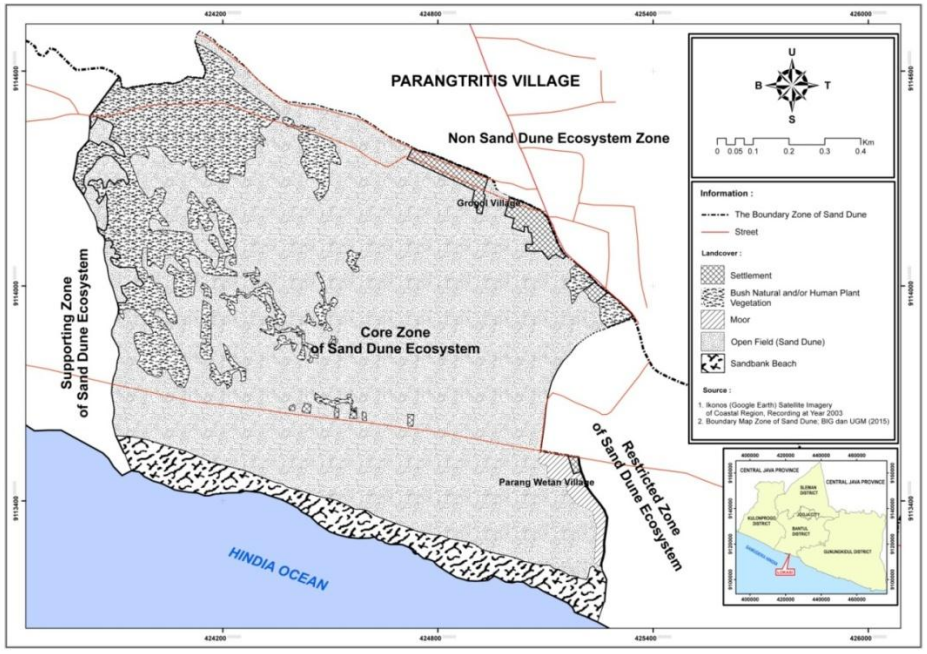

Figure 2. Map of the Core Zone Ecosystem Land Cover Sand Dunes in 2003

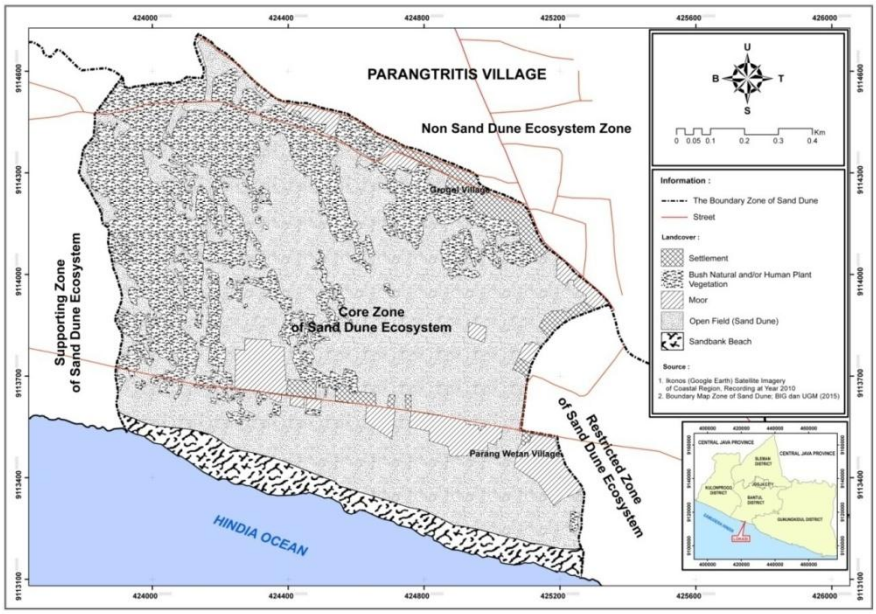

Figure 3. Map of the Core Zone Ecosystem Land Cover Sand Dunes in 2010

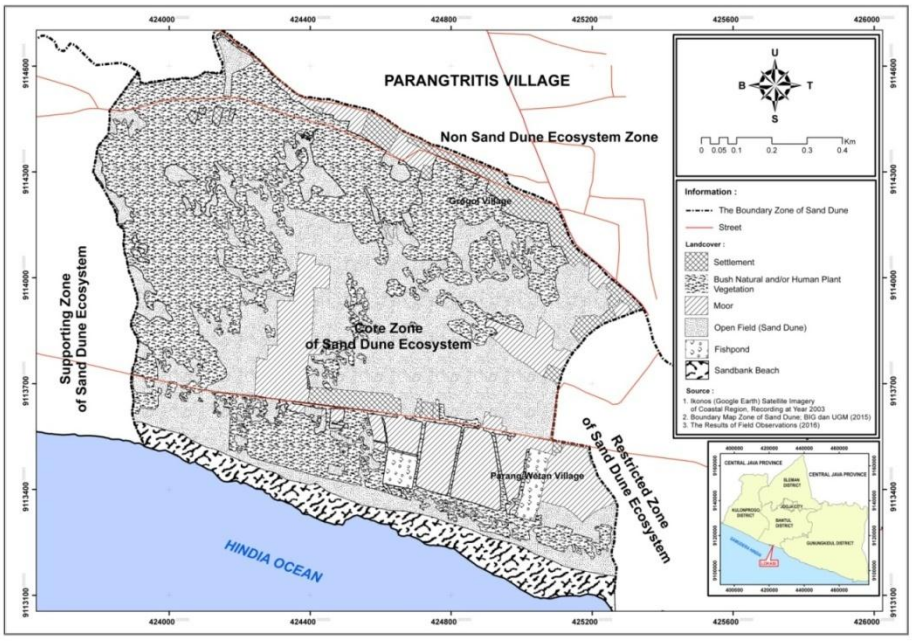

Figure 4. Map of the Core Zone Ecosystem Land Cover Sand Dunes in 2016

Table 2. Changes in land cover in core zone of sand dune ecosystem

No.	Land Cover	2003		2010		September, 2016		Information
		Large (ha)	%	Large (ha)	%	Large (ha)	%	
1.	Settlement	0.68	0.47	1.32	0.92	3.13	2.18	
2.	Moor	3.24	2.26	5.11	3.56	23.22	16.19	
3.	Bush natural and/or human plant vegetation	27.91	19.46	38.24	26.66	69.17	48.22	Sand Dune
4.	Fishpond	-	-	-	-	1.11	0.77	
5.	Sandbank beach	1.38	0.96	1.23	0.86	0.34	0.24	
6.	Open field	110.23	76.85	97.54	68	46.47	32.4	Sand Dune
	Total Amount	143.44	100	100	100	143.44	100	

Land cover data in Table 2 show that the intensity of development occurs extents of land cover types on the type of moor, scrub natural and human plant vegetation, ponds, and settlements. Forms sandbanks which growth by natural bush and plant vegetation man is still visible. Refinement/area reduction of land cover types occurred on the type of coastal shoals and open land. Shoal beach area reduction caused by widespread and increasing the surrounding land cover types. Open land in the form of sand dunes on the wane due to the reduction in beach sand deposits as a source of sandbanks. The formation process is still ongoing sandbanks actively open land rested on the sandbanks. Region shrimp ponds spread sand dune fields occupy the unit.

3.2 Rainfall and trend analysis

Rainfall is one of the elements of the climate, is one trigger the development of life of vegetation and landforms sand dune formation process. Rainfall is the main source that supplies water to the soil and rocks, forming groundwater in sand dunes and the surrounding ecosystem. Rainfall conditions used in the study are the monthly averages for 19 and 28 years (adjusting the availability of data from the rainfall stations). Although data is not uniform rainfall amount, but it can be well-represented on the seasonal pattern of research areas. Data and measurement time rainfall has been calculated in the form of monthly averages are presented in Table 3. The pattern of rainfall and rainy season in the study are presented in a graph of Figure 5.

Table 3. Mean Monthly Rainfall in Regional Research

Rainfall station and Year	**Average Monthly Rainfall (mm)**											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Brosot 1985 – 2013 *	339	289	293	226	88	57	17	2	23	50	159	365
Sanden 1996 – 2015*	410.7	385.8	391.8	303.3	219.8	65.1	38	19	33.4	48.4	280.3	548
Gondongan 1996 – 2015 **	329.9	313	319.9	250.1	152.1	63.3	47.6	4.8	24.3	59.3	235.8	504.6
Total	**1,079.6**	**987.8**	**1,004.7**	**779.4**	**459.9**	**185.4**	**102.6**	**25.8**	**80.7**	**157.7**	**675.1**	**1,417.1**
Average	**359.9**	**329.3**	**334.9**	**259.8**	**153.3**	**61.8**	**34.2**	**8.6**	**26.9**	**52.6**	**225**	**472.5**

Source: * Central River Region Serayu Opak, Yogyakarta, 2016.
** Meteorology and Geophysics Agency in Yogyakarta province, in 2016.

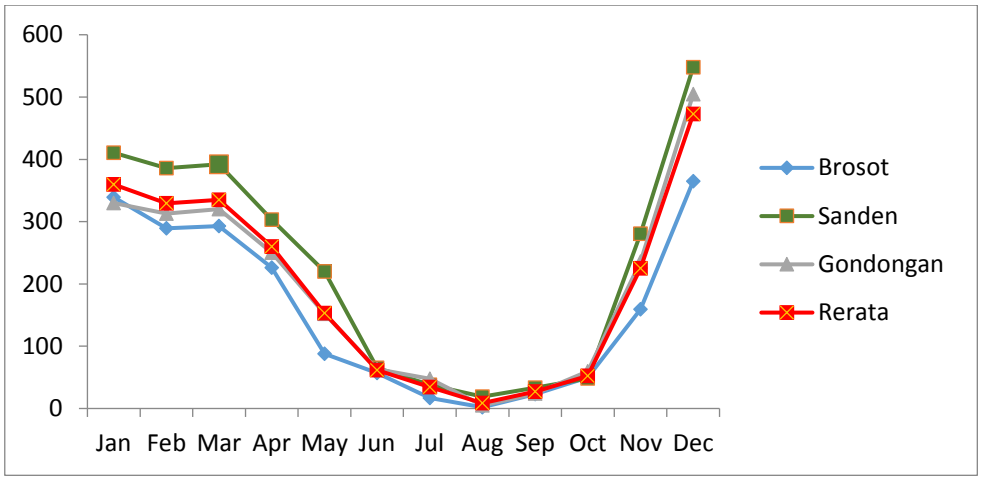

Figure 5. Pattern of Rainfall and Rainy Season in Regional Research

Referring to the criterion of rain according to Mohr, 1933 in Bayong 2004 the rainfall and weather patterns in the study area based on rainfall data the average monthly in Table 3 and the presentation in the form of the graph in Figure 5, it can be concluded that the rainy season in the area of research takes place between the months of November to June, while the dry season lasts between the months of June to October. Conditions of transition between the dry to the rainy season occurs in June, while the condition of the transition between the dry season to the rainy season occurs in October.

Based on the level of dignity of the rainfall in the study with reference to the level of dignity Table 1, the average monthly rainfall scored research area 2 (two) and include many criteria. The amount of rainfall is a major source of water into the soil and rock to form groundwater, affecting the activity of sandbanks. Rainfall and liveliness sandbanks affect vegetation growth.

Rainfall data in the rainfall stations located or near the area bersistribusi not normal, then transformed by the natural logarithm. The test results for normality in Brosot station and mumps have P_VALUE> 0.10 so that all the data had normal distribution. After normality test later trend analysis. The results of trend analysis concludes that there is a pattern of a tendency to increase the amount of rainfall in the area of research. This resulted in higher material holding capacity, deflation process was not optimal, and the growth of vegetation spreading. Sand dune fixation process resulting from active to inactive.

3.3 The Dynamic Sand dune Formation Process and the Relation With Climate Change

Parangtritis beach sand dune formation is dynamic, influenced by the movement of sand and dust by the winds that blow from the sea-shore. The process depends on the speed with payload power, wind turbulence, high wind flow from the surface, cohesion, the nature of the surface roughness, grain size of the material surface, and the presence of obstructions so that the wind change process. The transfer of material sand and dust by the wind process

called deflation, and deflation may occur by the process of wind erosion processes. Understanding of deflation (deflation) in accordance delivered by Strahler and Strahler (1989) is the displacement in the form of lifting and transportation of material sand or dust by wind activity. In the area Parangtritis material resources of sand and dust from the waterfront transported by wind (deflation) and sedimentation. The results of ongoing sedimentation and then deflated and sedimentation again, to the limit of deflation ends towards the north..

The formation of the sand dune area of research based on the results of field observations, it is known that the formation of sand dunes forms influenced by the controller in the form of sand-sized material from 0.5 to 0.125 mm (medium sand - fine sand) and <0.0625 mm (dust), material it is not coherent (not solid) that can be displaced by a triggering factor such as wind activity. The triggering factors such as wind, are also affected by the climate (temperature and precipitation) and human activities (farming, gardening, pond, home-settlement activity trail bike riding, sandboarding and others). By controlling and trigger factors can affect the activity of the formation of sand dunes and sandbanks specific shapes become deformed.

Parang climatic conditions such as regional climate conditions are wet tropical rainy season occurs in November to June, occurred in the dry season from June to October. Conditions of transition between the dry to the rainy season occurs in June, while the condition of the transition between the dry season to the rainy season occurs in October. The development of the season in years past (especially in the year 2016) the longer the rain. These conditions resulted in the formation of sandbanks become inactive during the rainy increasingly longer dry season. Not active process of formation of sand dunes, will provide growth opportunities shrubs naturally in the form of grass running / grass Wind (*Spinifex littoreus*), pandanus thorns, thistle (*Calotropis gigantea*), and palm / palm or the growth of plants by humans in the form of pine shrimp (*Casuarina equisetifolia*), acacia (*Acacia concurrens*), cashew (*Anacardium occidentale*). In recent years this plant grass wind beautiful and attractive, increasingly less common.

3.4 The types of vegetation as a form of adaptation is found in the study area

Sand dunes can move on, when there are no obstructions vegetation and persistent forms of sandbanks altered by wind currents, or may be inactive, when it is covered by vegetation and roots that prevent a further shift of sand (Strahler and Strahler, 1989). Santosa (2010), suggests that the existing sandbanks called dune vegetation steady (fixed dune) given the changes in form and difficult displacement takes place. The vegetation on sand dune resulted in friction between the wind and sand dune material is hindered. Unlike the case with sandbanks that there is no vegetation or sand dune called active sand dune, which tend to be more dynamic to the formation and morphological changes of sand dune, due to wind

activity that is not obstructed by vegetation. The process of development of active dunes become steady dune called dune fixation process. Fixation process sandbanks have been put forward by Suastika (1997), that the fixation process because of the main factors, namely the availability of the materials sand and the power of wind to work, and can also by biological factors as a result of plant growth vegetative might speed up the process (adaptation of plants) ,

The type of vegetation cover common in sand dunes in the southern coastal district of Bantul, Yogyakarta is: katang-katang / tread goat (*Ipomea pes-caprae*), lawn wind (*Spinifex littoreous*), pandan (*Pandanus tectorius*), and the thistle (*Calontropis gigantae*) Teki sea (*Cyperus martima*), Hyacinths (*Crinum asiaticum*), Gabusan (*Scaevola taccada*) and the types of plants other gummy. Currently found various types of human cultivation of plants in sand dune area. Type of plant is comprised of coconut (Cocos nucifera), pine (*Casuarinas equisetifolia*), tree dragon fruit (Pitaya), mango (*Mangifera indica*), rambutan (*Nephelium lappaceum*), lime (*Citrus aurantifolia*), betel nut (*Gnetum gnemon*) , bintangur (*Calophyllum inophyllum*) or nyamplung (name of Java), ketapang (*Terminalia catapa*), mire (*Baringtonia asiatica*), hibiscus (*Hibiscus tiliaceus*), gamal (*Glirisida sipium*), keben (*Barringtonia asiatica*), and others.

Types of plants on the moor, in the form of annual crops of high economic value, namely watermelon (*Citrullus vulgaris*), melon (*Cucumis melo* L.), watermelon (*Citrullus vulgaris*), purple eggplant (Solanum melongena), onion (*Allium cepa*), curly red chili (*Capsicum annuum*), bean (*Vigna sinensis*), cucumber (*Cucumis sativus*), corn (*Zae mays*), and others.

5 CONCLUSION

There is a link between land cover changes in rainfall, which with the growing length of time the rain had caused the land sandbanks able to adapt, which has the availability of sufficient water to develop the types of crops conducted by human activity. Causing an open area of sand dunes on the wane. The forms of adaptation that occurs increasingly seen in the great variety of crop species which can be found in the current ecosystem of sand dunes.

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